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ABSTRACT

Materials from an individualized Algebra I program were used by 307 experimental students in ten classrooms of nine public junior and senior high schools. A control group of 250 students in ten classrooms used a traditional textbook approach to Algebra I. Achievement of the total experimental and control groups as measured by the Lankton Test was found to be not significantly different although slightly in favor of the total control group. The attitudes of students toward mathematics as measured by the Revised Mathematics Attitudes Scale were found to be significantly different in favor of the experimental students (.1 level). The post field test use of the materials and a projected Algebra I program are discussed. (MN)

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A DESCRIPTION OF THE CONSTRUCTION AND EVALUATION OF AN INDIVIDUALIZED ALGEBRA 1 PROGRAM

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A DESCRIPTION

OF THE

CONSTRUCTION AND EVALUATION

OF AN INDIVIDUALIZED ALGEBRA I PROGRAM

by

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St. Augustine High, St. Augustine

Mr. Frank Warriner, Principal
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Union County High, Lake Butler

PREFACE

The primary function of P. K. Yonge Laboratory School is to conduct research and development in service to the public schools of the State of Florida. Since being assigned that role in 1970, 51 research and development projects have been conducted. Findings of 22 projects, including the one discussed in this monograph, have been verified by field tests in 208 Florida public schools in 49 of the State's 67 counties.

It is always gratifying to report findings about programs and processes which achieve highly effective results. On occasion, however, implications demand considerable rethinking. Such is the case with the Individualized Algebra I project. Although outcomes were positive at a statistically significant level for two-thirds of the 307 experimental students when compared with 250 controls, materials and processes must be reexamined in light of the remaining one-third who did not achieve an acceptable level of performance. Further, a number of questions were generated which must be answered before broad dissemination of the materials can be recommended.

If reading of this monograph stimulates among public school personnel sufficient interest in further study and cooperation in planning further investigation based upon the questions raised, the Laboratory School is in a position to conduct drive-in conferences and workshops at times and in locations convenient to public school personnel. If interested in pursuing these possibilities further, simply contact Dr. J. B. Hodges, P. K. Yonge Laboratory School, 1080 S. W. 11th Street, Gainesville, Florida, 32611.

Dr. J. B. Hodges, Director
P. K. Yonge Laboratory School
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A DESCRIPTION OF THE CONSTRUCTION AND EVALUATION OF AN INDIVIDUALIZED ALGEBRA I PROGRAM

In most schools the students enrolled in Algebra I exhibit a wide range of interests and abilities. The wide range of abilities of students in this course is a result of the importance that students, teachers, and particularly parents, place on the course as an indicator of academic success, present and future.

The general existence of a wide ability range and the fact that success in Algebra I is vital for further study of mathematics are important reasons for structuring the course in a way designed to encourage individual success.

Construction of Program and Materials

The attempt to construct a program which facilitated individual success began with an assumption that Algebra I is a generally identifiable collection of sequential skills and ideas. Student pace was identified as the primary variable in individualizing Algebra I since the skills necessary for further study are essentially constant. Freedom from a group determined pace would allow adequate time for each student to master each skill as he progresses through the course prior to moving on to the next topic and would allow some students to acquire the required skills at an accelerated rate.

Materials were written to allow students to acquire skills of Algebra I at individual rates. The Algebra I subject matter was divided into eleven sequential topics. The materials caused students to focus on particular skills as they progressed through each topic. Frequent evaluation of student skill acquisition was included, and successful acquisition of each skill was the prerequisite for continuing through the topic. The rate of student progress through each topic was determined by the rate of successful acquisition of the skills.

Initially, several worksheets were written for each topic. They varied in length from one to four pages. Each introduced or explained a skill or some part of a skill, included examples, and provided exercises and problems. Each worksheet provided space for student computation after each exercise or problem. The worksheets were printed on only one side to provide additional space

for student computation and for teacher use in writing comments and supplementary exercises for individual students.

Quizzes and tests were written and were available when needed by a student. The quizzes were scheduled to be taken after a student had completed two or three worksheets. The quizzes served as frequent check points to make certain that a student had acquired a skill before progressing to the next one. Alternate quizzes were written for students who were not successful on a quiz. A teacher conference was required for these students to correct their misunderstandings and to assign supplementary exercises prior to the students' taking the alternate quiz. A review worksheet on each topic was constructed. A teacher conference after the completion of the review worksheet was held to identify and remedy any weaknesses in the students' understanding of the topic. The test on the entire topic followed this conference.

Modifications were made in the structure and use of the materials during the first year of use at P. K. Yonge. Some factors which caused the modifications to be made were excessive student traffic, loss of materials, and excessive paperwork. Eleven booklets were formed from the worksheets by combining the worksheets related to each topic. A booklet included a schedule for taking the quizzes and tests for that topic and answers to exercises and problems on all the worksheets except the review worksheet. Giving a booklet rather than a worksheet to a student reduced the loss of materials and student traffic in the classroom. The inclusion of answers relieved the teacher of checking each worksheet and allowed students to check their work immediately.

The Algebra I materials were mimeographed at P. K. Yonge for student use. A set of materials for a student consisted of the eleven booklets or units and the quizzes and test for each unit. The materials for one student consisted of a total of 337 pages. The storage of materials so that they were available for a class of thirty students required a minimum space of one filing cabinet for the quizzes and tests and shelf space for booklets not in use.

Field Test

After the materials were used at P. K. Yonge, it was decided to field test the materials in the public schools to examine their general effectiveness.

Experimental and control classrooms were obtained through the assistance of the Florida Educational Research and Development Council. The P. K. Yonge Algebra I materials were used by a total of 307 experimental students in ten classrooms in nine public schools. A control group of 250 students in ten classrooms of public schools used a traditional textbook approach to Algebra I.

Achievement of students was compared using the Lankton First Year Algebra Test. The achievement test was administered to control students at the end of the school year. The experimental students took the achievement test as they completed the materials or at the end of the school year if they had not completed all of the eleven units.

The attitudes of students toward mathematics were also measured. The Revised Mathematics Attitudes Scale was the instrument used for measuring attitudes toward mathematics. Data were also solicited from experimental groups concerning the reading ability of students as a result of the amount of reading required for individual progress.

Finally, since the P. K. Yonge materials were created to allow individual progress, the effect of time to complete the materials on achievement was examined. Comments concerning the use of the materials were solicited from teachers and students.

Results of the Field Test

The existence of individual rates of progress for experimental students is evident when time to complete is examined. Seventy-one students were able to complete the materials in thirty weeks or less. A total of 105 students finished the materials in less than a school year of thirty-six weeks, and a total of 200 students were able to complete all eleven units during the school year. One hundred seven students did not complete all eleven units during the field test.

The mean raw scores obtained by the control and experimental groups are shown in the table which follows. The indicated percentiles were computed from a national sample of first year algebra students. The Lankton mean raw score was computed for two control groups as a result of one of the control group classes obtaining a mean raw score at the 98th percentile. Justification for throwing out the data for this class did not exist, but the nature of the student population was such that it was decided to consider a control group without that class.

Group	Number of Students	Lankton Mean Raw Score	Percentile
Total Control	250	25.6	71
Control (98 percentile class deleted)	223	23.7	67
Total Experimental	307	25.1	71
Experimental Students Completing in 30 Weeks or Less	71	31.0	88
Experimental Students Completing in 35 Weeks or Less (any less than a full school year)	105	30.2	86
Experimental Students Completing in 36 Weeks or less (a full school year)	200	27.6	80

Achievement of the total experimental and control groups as measured by the Lankton Test was found to be not significantly different although slightly in favor of the total control group. However, if the scores of the control group class that obtained a mean raw score at the 98th percentile are omitted from the calculations, there is a difference in favor of students' using the P. K. Yonge materials at the .1 level of significance. All of the mean raw scores of the subgroups of the experimental group are significantly different from the mean raw score of the control groups at the .001 level of significance.

The attitudes of students toward mathematics as measured by mean scores obtained on the attitude scale were found to be significantly different in favor of the experimental students at the .1 level of significance.

Data were available concerning the reading ability of 221 of the experimental students. The correlation between algebra achievement as measured by the Lankton raw score and reading ability as measured by relation to grade level was examined using the Pearson Product Moment Coefficient of Correlation. An r of .59 was obtained indicating a correlation significant at the .001 level of significance.

Frequent positive student comments relating to the use of the materials, mentioned being able to work at one's own speed, being able to understand explanations, and being able to write directly in the units. Frequent negative comments indicated that some explanations were not adequate by themselves. Teachers indicated a need for many more exercises and problems in the materials.

Discussion of the Results

The results indicate that it is possible for classroom teachers to write materials the use of which will result in achievement at least at the level obtained with a traditional textbook approach. The results certainly indicate that it is possible to structure classroom experiences of students in a manner that will allow individual rates of progress. The number of students who completed the materials in less than a school year and the number of students who did not complete all eleven units are both indicators of varying rates of progress.

An important result of the field test was the finding that some of the experimental students were able to complete the materials in considerably less than a full school year and still achieve at a high level. These students achieved at the 88th percentile compared with the achievement of the total control group at the 71st percentile. The achievement at the 86th percentile of the students who completed the materials in any less than a full school year is also important to consider.

Approximately two-thirds of the experimental students completed the materials during a school year and achieved at a more than adequate rate. However, a great deal of consideration must be given to the fact that 107 students were not able to complete the eleven units during the school year. The mean raw score of this group of students on the Lankton Achievement Test was 20.4 which is at the 50th percentile. This lower score than other groups is to be expected since these students were not exposed to all of the material normally contained in Algebra I.

The correlation of reading ability and achievement was not surprising. Such correlation should be expected for any program that requires independent student progress.

Post Field Test Use of the Materials

The results of the field test and experience in the use of written materials indicated the need for change in the P. K. Yonge use of the materials. Two problems which resulted from the individually paced program were: (1) what provisions to make for students who finished the course before the end of the year, and (2) what provisions to make for students who did not finish the course by the end of the year.

One approach to these problems would be to restructure the entire mathematics curriculum to provide mathematics courses or activities for these two very different groups of students. The students who complete Algebra I prior to the end of the year would need to begin another mathematics course or mathematics experience when they finished Algebra I. For the students who did not finish Algebra I in a year, provisions would need to be made for their completing the course the next year. Appropriate mathematics courses or courses in other subject areas would need to be available to the students finishing Algebra I before the end of the second year.

The restructuring of the total mathematics curriculum at P. K. Yonge would be impractical because of the small student population and small mathematics department. The total enrollment in Algebra I is less than eighty, therefore the total number of students who finish before the end of the year and who do not finish by the end of the year would be very small. The total number of students is too few to warrant a complete restructuring of offerings in mathematics, and the size of the mathematics faculty is too small to staff the program which would evolve.

These factors made it necessary to make changes in the use of the materials so that all Algebra I students at P. K. Yonge would finish the course at the end of the school year. A topical approach was used in which the entire class dealt with a topic for a certain period of time. The progress of the majority of the class determined the time spent on a topic. Previous experiences with the materials showed that additional exercises and problems were needed to supplement those included in the materials. Supplementary work from textbooks was given to individual students and to the entire class as needed. The faster students were allowed to work ahead of the class within a unit and were given additional experiences with each skill. The faster students seemed to profit more from additional work within a unit than from moving ahead to the next unit. However, a small number of exceptional students were allowed to move ahead for short periods of time. All

students did at least a portion of the work in every unit. Individualization within units was emphasized rather than individualization of rate of progress through the entire course. The topical approach eliminated the need for evaluating students at different times. Quizzes and tests were given to the entire class at the same time. Additional quizzes and tests were constructed and given as needed. The use of the topical approach resulted in all Algebra I students finishing the course at the end of the year. The decision to make one year the length of the Algebra I course made it easier to fit into the existing structure of the remainder of the mathematics curriculum.

Projected Algebra I Program at P. K. Yonge

The use of the topical approach and the one-year length of the Algebra I course will be retained in the P. K. Yonge Algebra I program. However, the major classroom resource will be an Algebra I textbook. The Algebra I materials for students were entirely consumable and had to be reproduced each year at P. K. Yonge. The reproduction, which included typing the stencils, mimeographing, collating, and assembling the booklets, required many hours of work by the secretarial staff and used a large amount of paper. These factors affected the decision to change the major classroom resource to a textbook rather than to deal with the continuing problems of reproducing the materials. It should be emphasized that the commitment to individualize the learning of Algebra I remains the focal point of the P. K. Yonge program.

The topical approach will still emphasize individualization within units. The entire class will work together on a topic. However, exceptional students will be allowed to work ahead of the class for short periods of time and will be given supplementary exercises. Additional materials will be provided as needed for individual students and for the entire class. The nature of the work within each topic may vary with the student, but the entire class will study portions of each topic of the course. This structure will insure that students will complete Algebra I at the end of the year.

Questions for Consideration

The experience of the construction, evaluation, and subsequent modification of an Algebra I program which emphasizes individual learning resulted in the identification of certain questions concerning the nature and effects of an individualized program. The following

questions should be considered by a school or system contemplating the individualization of Algebra I.

What affect does the size of a school and the number of Algebra I students have on the nature of an individualized program? A large school with more course offerings may find it easier to fit an individualized program into the existing structure. Large Algebra I student populations may make it feasible to consider different individualization approaches for portions of the student population.

What will be the major instructional resource for the program? Should materials be constructed, or should the program be constructed around available textbooks? The nature of the student population for which the program is being constructed is an important factor.

What affect will individual completion rates of Algebra I have on the remainder of the mathematics sequence? The school must provide for the students who complete the course requirements in less than or more than a school year. Schools that have a large number of courses of less than a year in length may find this to be a less significant problem. It should be emphasized that these two groups of students will require a considerable difference in the nature of activities designed for them.

How will completion of the course be defined? It is important that students and parents be made aware of the course requirements at the beginning of the course. Experience with a program may result in modification of the requirements for completion.

How will the structure of the program place emphasis on skill acquisition? Frequent evaluations are necessary to insure that students do not progress through the program beyond adequate understanding. The accelerated rate of high ability students may cause some other students to attempt to progress through a program at a rate faster than productive for them. If the status of speed cannot be minimized adequately, some students may resort to cheating in order to attempt to maintain a high rate of progress.

How will the program be structured to insure continuing progress? An individualized program requires a degree of student self-direction. Some students will need a great deal of supervision to insure continuing progress. This may have been one of the factors that caused some of the field test students not to complete the program in a school year. It must be stressed that no progress is not a student option in an individualized program.

How will the teacher role in the classroom be affected? Emphasis on individualization will result in the teacher's being more of a resource person than a group leader.

Will changes in the grading system be required? Does emphasis on individual learning result in the need for a more individualized grading system? Variation in time to complete topics and in content examined may cause need for modification of a traditional grading system. It should also be mentioned that the structure of an individualized program may affect the awarding of Carnegie Unit credits.

Is the individualized approach the best for all of the Algebra I student population? The results of the field test indicate that two-thirds of the experimental population achieved at a more than adequate rate, but one-third of the experimental group did not complete the program and obtained a low rate of achievement. The field test did not produce data concerning why these students were not as successful. It would be very helpful if student attributes could be identified as predictors of success or of difficulty with an individualized approach. Reading level should be considered important for a program that requires individual progress. Measures of maturity and emotional development would also be helpful. Perhaps a great deal of information concerning a student's possible success in an individualized program could be obtained by examining the student's Myers-Briggs personality type and cognitive style mapping.

Conclusion

The objective of P. K. Yonge mathematics instructors was to construct an Algebra I program which facilitated individual success. In the process of creating materials, field testing, evaluating, and modifying, it became evident that the construction of an individualized program is of a continuing nature. Modification and evaluation will continue to be an integral part of the process of individualizing Algebra I at P. K. Yonge. The goal of this process is to acquire results which will help Algebra I teachers to be more effective in individualizing Algebra I instruction.